U.S. Fish and Wildlife Service
West Virginia Field Office

Guidance on Developing and Implementing a Myotid Bat Conservation Plan

Introduction

Various land development and land use activities can cause the loss, degradation, and fragmentation of Indiana bat and northern long-eared bat (NLEB) habitat. Significant adverse habitat impacts can result in the death or injury of these bats by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Within its legal authorities under the federal Endangered Species Act (ESA; 16 U.S.C. 1531-1543), the U.S. Fish and Wildlife Service (Service) is often in the position of providing technical assistance to project proponents to assist them in determining if potential adverse effects on Indiana bats and/or NLEB are likely to occur and, if so, how they can avoid, minimize, and/or offset those adverse effects. In many cases, potential adverse effects can be avoided or greatly reduced by early project planning that incorporates the measures outlined below. This guidance can be used to develop conservation plans for Indiana bats, NLEB, or both.

This guidance consolidates and streamlines technical advice currently provided on a project-by-project basis. Frequently, these project-by-project reviews include considerable explanation of bats needs and responses to habitat loss, degradation, and fragmentation. To provide similar context for this document, Appendix A provides summary background information concerning Indiana bats and NLEB.

Rationale for Plan Development

The unauthorized "take" of federally listed species is prohibited pursuant to section 9 of the ESA. "Take" is defined in the ESA as: to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. "Harm" is further defined to include significant habitat modifications or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. "Harass" is further defined as actions that create the likelihood of injury to listed species to such an extent to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Where there is a risk of take occurring (*e.g.*, due to effects caused by the proposed loss of forest habitat), this guidance details specific measures that can be taken to avoid, minimize, and offset potential adverse effects on the Indiana bat and/or NLEB, and significantly reduce the likelihood that take will occur. In some cases, application of this guidance may be sufficient to determine that effects on Indiana bats and NLEB are insignificant or discountable. In other cases, this determination may be met through different or greater measures built into project design. In any instance where project design and Myotid Bat Conservation Plan (MBCP) implementation successfully avoids potential adverse effects on bats, it would preclude the need for take exemption or authorization, and project proponents

would be able to forego the lengthy regulatory process associated with seeking "take" authorization under the ESA.

The development and implementation of a MBCP does not itself confer incidental take exemption or authorization. Consequently, if implementation of a MBCP is not sufficient to avoid potential adverse effects, incidental take would be exempted or authorized only via the issuance of biological opinions pursuant to Section 7 of the ESA, or incidental take permits pursuant to Section 10 of the ESA.

This is "guidance" and not policy, a project proponent or applicant has the option of not following the Guidance's recommendations when providing information to the Service, however, this will likely increase review times or result in projects that will adversely affect Indiana bats and/or NLEB and, therefore, require formal consultation.

Plan Development and Implementation

To avoid or minimize potential adverse effects on Indiana bats and NLEB, project proponents should develop and implement a MBCP when a project will affect forests, woodlots, forested fencerows, riparian areas, or trees within areas that are known or potential Indiana bat or NLEB habitat. Known Indiana bat habitat includes habitat located 1) within 5 miles of an Indiana bat female (reproductive or non- reproductive) or juvenile capture record without an identified maternity roost tree; 2) within 2.5 miles of an Indiana bat maternity roost or male bachelor colony record; and 3) within 10 miles of a priority 1 or 2 hibernaculum or 5 miles of a priority 3 or 4 Indiana bat hibernaculum. Known NLEB habitat includes habitat located 1) within 5 miles of a hibernaculum; 2) within 1.5 miles of a summer maternity roost; and 3) within 3 miles of a NLEB capture site, with no roost identified.

Potential Indiana bat and NLEB habitat includes all suitable foraging and roosting habitats and travel corridors where surveys have not been conducted to determine if bats are present, but presence is being assumed. The MBCP should consider the various sources and types of effects on Indiana bats and/or NLEB due to project development, and incorporate measures to avoid, minimize, and offset potential effects[1]. It is important to note that "project" includes all project features, not just the portion of the project prompting the submittal of a permit application (*e.g.*, to WVDEP or the Corps). For example, a residential development would include all features of the development, including all forest or wooded areas to be affected or encroached upon by roads, utility lines, houses, driveways, septic areas, detention basins, stormwater basins, yards, lots, *etc*. An oil or gas project would include not only the well and well pad, but also the roads, staging areas, impoundments and holding pits, and oil and gas lines associated with the well or well field.

The MBCP becomes an integral part of the proposed project, and as such, is something the project proponent or applicant commits to implement. In order for consultation conclusions to remain valid, the MBCP must be incorporated as a required condition in any permits or authorizations issued for the

[1] This approach is sequential, meaning all reasonable efforts should be taken first to avoid adverse effects on Indiana bats and/ or NLEB and their habitat. Then, minimization measures should be implemented to the maximum extent practicable. After both avoidance and minimization measures have been fully integrated into project design, include measures to offset or partially offset any remaining adverse effects on Indiana bats and/or NLEB and their habitats.

project. Prior to initiation of any project construction, send the MBCP to the Service for review[2]. The Service will evaluate the proposed project, along with its MBCP, to determine whether or not the combined effects of the project and MBCP will result in insignificant or discountable effects on the Indiana bat and/or NLEB and its habitat, or whether further consultation and coordination would be necessary due to continued adverse impacts or the likelihood of take of listed bats.

Plan Content

Provide a detailed project description and map, including all project features. Include project name, company, area size (acres), acres and location of forest in the project area that will be removed and that will remain undisturbed, timing of forest removal, and any measures proposed to avoid, minimize or offset lost forest habitat or permanently protect forest habitat off-site for Indiana bats and/or NLEB.

Provide a list of all avoidance, minimization, and conservation measures that will be implemented, explaining how each measure will be implemented for the proposed project. The MBCP at a minimum must include a description of how impacts have been avoided and minimized to the maximum extent practicable and must include seasonal clearing for all trees greater than 3 inches DBH that will be removed. Recommendations of potential conservation measures can be found in Appendix B.

An on-site assessment of the quality and quantity of suitable bat habitat present within the project area should be performed by qualified biologists with knowledge and experience with Indiana bat and /or NLEB habitat requirements, such as those listed in the List of Surveyors Qualified to Conduct Myotid Bat Surveys in West Virginia. This assessment should include a detailed analysis of potential roost trees that may be affected by the project as well as a description of potential foraging and commuting areas present within the project area. A table for recording potential roost trees is available in Appendix D.

Due to the large amount of tree clearing and overlapping projects occurring across the state of West Virginia, the Service is now requesting that you list past and future projects proposed by your agency/company in the last 5 years that have/will occur inside your buffer area (2-mile buffer from centerpoint of non-linear projects and ¼-mile buffer from centerline of linear projects) of your project. This data will help us to better conserve bat resources, ensure that effects from interrelated and interdependent projects are considered, evaluate cumulative impacts, and better implement recovery efforts for these species. A table for recording past/future projects is available in Appendix E.

The number of acres existing within 2-miles from the centerpoint of non-linear projects, and within ¼-mile from the centerline of linear projects should be included. The number of forested acres in this buffer area (either 2-mile area or ¼-mile area) pre- and post-construction should also be included.

Additionally, a cave and mine portal search within the project area should be performed in accordance with the Phase I Cave/Mine Portal Survey Data Sheet and completed for each opening found. This data

[2] **Note that ALL tree removal within known Indiana bat and NLEB habitat – regardless of the amount – is subject to the appropriate seasonal restriction.** We recommend that even projects with relatively small-scale forest impacts (*e.g.*, less than seventeen acres) consider developing and implementing a MBCP, because in doing so, the cumulative forest losses from a multitude of such projects would be reduced. Nevertheless, when total forest impacts are expected to be less than seventeen acres (this number is currently being re-evaluated and may need to be adjusted for NLEB) and the project is outside known Indiana bat and/or NLEB habitat, the associated MBCP does not require U.S. Fish and Wildlife Service review and approval.

sheet is enclosed and results should be compared against the criteria listed in the Draft Protocol for Assessing Abandoned Mines/Caves for Bat Use. This survey can be performed by mining engineers, other field personnel, or biologists with experience identifying caves or mines. The survey should include a review of topographic, mining, karst occurrence, and environmental resources information maps; as well as actual field reviews of the entire proposed project area. For linear projects (e.g., transmission lines, natural gas pipelines, highways, and access roads), the field survey should include lands buffering the disturbance footprint of the proposed linear project, extending to 0.6 mile (1 km) on each side of the outer edges of the footprint.

A summary sheet of all of this information is included on the following page. This summary sheet should be included at the beginning of your submitted MBCP. Appendices A through F provide additional information and forms to aid in your submittal of your MBCP.

If you have further questions that have not been addressed within this document or its appendices, please check our Frequently Asked Questions document at the following link:

http://www.fws.gov/westvirginiafieldoffice/PDF/WVFO_FAQs.pdf

If your question was not answered through any of these methods, please contact our office at 304-636-6586.

Indiana Bat/Northern Long-Eared Bat Summary Sheet for Option 1: Assumption of Presence

Project Name: _____

Project Location: _____

County: _____

Project type: linear / non-linear

(**2-mile buffer** from centerpoint for non-linear; **¼-mile buffer** around centerline for linear)

SUMMARY TABLE OF PROJECT ACREAGE IMPACTS

# acres within the Project Area:	
# acres of forest to be cleared within the Project Area:	
# acres forest in the Project Area prior to project construction:	
# acres forest in the Project Area following to project construction:	
Total # acres in buffer area (λ): (**2-mile buffer** from centerpoint for non-linear; **¼-mile buffer** around centerline for linear) *(2-mile buffer area is always 8,042 acres for non-linear projects)*	
# forested acres in buffer area prior to project construction:	
# forested acres in buffer area after project construction (α):	
% forest remaining within buffer area post-construction ($(\alpha \div \lambda) \times 100$):	%

Caves/mine portal presence? Yes / No

***If yes,* suitable habitat?** Yes / No

SUMMARY TABLE OF IMPACTS TO POTENTIAL ROOST TREES

(use best professional judgement to categorize potential roost trees below; trees should not be classified into more than one category)

TOTAL # Potential Indiana Bat Primary Roost Trees within the Project Area:	
# Potential Indiana Bat Primary Roost Trees to be avoided:	
# Potential Indiana Bat Primary Roost Trees to be impacted:	
TOTAL # Potential NLEB Primary Roost Trees within the Project Area:	
# Potential NLEB Primary Roost Trees to be avoided:	
# Potential NLEB Primary Roost Trees to be impacted:	
TOTAL # Potential Indiana Bat Secondary Roost Trees within the Project Area:	
# Potential Indiana Bat Secondary Roost Trees to be avoided:	
# Potential Indiana Bat Secondary Roost Trees to be impacted:	

Avoidance and Minimization Measures to be Applied on Project

- ☐ Seasonal tree clearing (all trees greater than 3" DBH) **REQUIRED**
- ☐ Avoid cutting potential roost trees
- ☐ Avoid high quality foraging areas
- ☐ Minimize limits of disturbance (narrowed LOD or ROW)
- ☐ Minimize impacts (clearing) around suitable swarming and summer habitat and wetland/riparian zones
- ☐ 50-foot or greater forested buffer left along both sides of streams
- ☐ Collocate project features with previously disturbed or cleared areas
- ☐ Phase tree clearing over multiple years
- ☐ Reforest disturbed areas
- ☐ Restore or enhanced riparian/wetland areas
- ☐ Strong erosion and sedimentation best management practices
- ☐ Pollution control plan in place
- ☐ Suitable habitat acreage permanently preserved within or adjacent to the project site
- ☐ Other:_____
- ☐ Other:_____
- ☐ Other:_____
- ☐ Other:_____

Conservation Measures to be Applied on Project

- ☐ Girdling trees on a 1:1 ratio for each potential roost tree that is lost during project development (____ trees)
- ☐ Erecting artificial roosting structures on a 1:1 ratio for each potential primary roost tree that is lost during project development (a 2-year minimum monitoring plan of artificial structures) (____ structures)
- ☐ Erecting artificial bark, bat boxes, or other artificial roosting structures (a 2-year minimum monitoring plan of artificial structures)
- ☐ Preservation of suitable Indiana bat and/or NLEB habitat off-site (_____ acres)
- ☐ Creation of watering areas, wetlands, or ponds
- ☐ Other:_____
- ☐ Other:_____
- ☐ Other:_____

APPENDIX A *Indiana bat and NLEB– Background and Overview*

The Indiana bat is listed as "endangered" and the NLEB is listed as "threatened" under the ESA. NLEB and Indiana bats are both temperate, insectivorous, migratory bats that hibernate in mines and caves in the winter and spend summers in wooded areas. The key stages in their annual cycle are: hibernation, spring staging and migration, pregnancy, lactation, volancy/weaning, fall migration and swarming. While varying with weather and latitude, generally both species will hibernate between mid-fall through mid-spring each year. The spring migration period likely runs from mid-March to mid-May each year, as females depart shortly after emerging from hibernation and are pregnant when they reach their summer area. Young are born between mid-June and early July, with nursing continuing until weaning, which is shortly after young become volant in mid- to late-July. Fall migration likely occurs between mid-August and mid-October.

Summer Habitat and Ecology

Suitable summer habitat for the NLEB and Indiana bat consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. NLEB are typically associated with large tracts of mature, upland forests with more canopy cover than is preferred by Indiana bats. NLEB seem to be focused in upland, mature forests (Caceres and Pybus 1998) with occasional foraging over forest clearings, water and along roads (Van Zyll de Jong 1985). However, most NLEB hunting occurs on forested hillsides and ridges, rather than along riparian areas preferred by Indiana bats (Brack and Whitaker 2001; LaVal et al. 1980).

Many species of bats, including the Indiana bat and NLEB, consistently avoid foraging in or crossing large open areas, choosing instead to use tree-lined pathways or small openings (Patriquin and Barclay 2003, Yates and Muzika 2006). Further, wing morphology of both species suggests that they are adapted to moving in cluttered habitats. Thus, isolated patches of forest may not be suitable for foraging or roosting unless the patches are connected by a wooded corridor.

Maternity Colonies and Roosts

Upon emergence from the hibernacula in the spring, females seek suitable habitat for maternity colonies. Coloniality is a requisite behavior for reproductive success. NLEB maternity colonies range widely in size, although 30-60 may be most common. Indiana bat maternity colonies also vary greatly in size, with most documented maternity colonies containing less than 100 adult females. Both species show some degree of interannual fidelity to single roost trees and/or maternity areas. Unlike Indiana bats, male NLEB are routinely found with females in maternity colonies. Maternity colonies of both species use networks of roost trees often centered around one or more primary (Indiana bat) or central-node (NLEB) roost trees. Indiana bat maternity colonies use a minimum of 8-25 trees per season (Callahan et al. 1997; Kurta et al. 2002). NLEB roost networks also include multiple alternate roost

trees and male and non-reproductive female NLEB may also roost in cooler places, like caves and mines (Barbour and Davis 1969, Amelon and Burhans 2006).

Roost tree preferences vary between the two species. NLEB roost in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥3 inches dbh). NLEB are known to use a wider variety of roost types, using tree species based on presence of cavities or crevices or presence of peeling bark. NLEB have also been occasionally found roosting in structures like barns and sheds (particularly when suitable tree roosts are unavailable). A typical Indiana bat primary roost is typically located under exfoliating bark of a dead ash, elm, hickory, maple, oak, or poplar, although any tree that retains large, thick slabs of peeling bark may be suitable. Primary Indiana bat roosts are usually in trees that are in early-to-mid stages of decay.

Reproduction

Young NLEB and Indiana bats are typically born in late-May or early June, with females giving birth to a single offspring. Lactation then lasts 3 to 5 weeks, with pups becoming volant (able to fly) between early July and early August.

Migration

Males and non-reproductive females may summer near hibernacula, or migrate to summer habitat some distance from their hibernaculum. Indiana bats are known to often migrate hundreds of kilometers from their hibernacula. In contrast, NLEB is not considered to be a long distance migrant (typically 40-50 miles). Migration is an energetically demanding behavior for the NLEB and Indiana bat, particularly in the spring when their fat reserves and food supplies are low and females are pregnant.

Winter Habitat and Ecology

Suitable winter habitat (hibernacula) for both species includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). There may be other landscape features being used by NLEB during the winter that have yet to be documented. Generally, both species hibernate from October to April depending on local weather conditions (November-December to March in southern areas and as late as mid-May in some northern areas).

Hibernacula for NLEB typically have significant cracks and crevices for roosting; relatively constant, cool temperatures (0-9 degrees Celsius) and with high humidity and minimal air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible. Caves that meet temperature requirements for Indiana bats are rare. Most Indiana bats hibernate in caves or mines where the ambient temperature remains below 10ºC (50.0ºF) but infrequently drops below freezing (Hall 1962, Myers 1964, Henshaw 1965, Humphrey 1978). Caves that historically sheltered the largest populations of hibernating Indiana bats were those that provided the largest volumes and structural diversity, thus ensuring stable internal temperatures over wide ranges of external temperatures, with a low likelihood of freezing (Tuttle and Kennedy 2002).

Indiana bats generally hibernate in large clusters, sometimes with other species, with densities of 300 to 484 bats per square foot. NLEB tend to roost singly or in small groups, with hibernating population sizes ranging from a just few individuals to around 1,000. NLEB display more winter activity than other cave species, with individuals often moving between hibernacula throughout the winter (Griffin 1940, Whitaker and Rissler 1992, Caceres and Barclay 2000). Both NLEB and Indiana bats have shown a high degree of philopatry to the hibernacula used, returning to the same hibernacula annually.

Upon arrival at hibernacula in mid-August to mid-November, NLEB and Indiana bats "swarm," a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day. Swarming continues for several weeks and mating occurs during the latter part of the period. After mating, females enter directly into hibernation but not necessarily at the same hibernaculum where mating occurred. A majority of bats of both sexes enter hibernation by the end of November (by mid-October in northern areas).

After hibernation ends in late March or early April (as late as May in some northern areas), most NLEB and Indiana bats migrate to summer roosts. Female emerge from hibernation prior to males. Reproductively active females store sperm from autumn copulations through winter. Ovulation takes place after the bats emerge from hibernation in spring. The period after hibernation and just before spring migration is typically referred to as "staging," a time when bats forage and a limited amount of mating occurs. This period can be as short as a day for an individual, but not all bats emerge on the same day.

Spring Staging and Fall Swarming Habitat and Ecology

In general, NLEB and Indiana bats use roosts in the spring and fall similar to those selected during the summer. Suitable spring staging/fall swarming habitat consists of the variety of forested/wooded habitats where they roost, forage, and travel, which is most typically within 5 miles of a hibernaculum. This includes forested patches as well as linear features such as fencerows, riparian forests and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Isolated trees are considered suitable habitat when they exhibit the characteristics of a suitable roost tree and are less than 1,000 feet from the next nearest suitable roost tree, woodlot, or wooded fencerow.

Threats

The primary threats to Indiana bats and NLEB in West Virginia are white-nose syndrome (WNS), and habitat losses due to a wide variety of land development and land use practices that remove forest. WNS is causing significant mortality at numerous bat hibernacula, with Indiana bat mortality rates exceeding 60%. WNS has been particularly devastating for NLEB in the northeast, where the species was believed to be the most abundant. There are data supporting substantial declines in NLEB populations in portions of the Midwest due to WNS. In addition, WNS has been documented at more than 100 NLEB hibernacula in the southeast, with apparent population declines at most sites. WNS has not been found in any of the western states to date and the species is considered rarer in the western extremes of its range. We expect further declines as the disease continues to spread across the species' range.

Forest habitat losses occur due to coal mining, wind power development, oil and gas development, commercial and residential development, and various forestry practices. These habitat losses have the potential to adversely modify Indiana bat and NLEB suitable roosting/foraging habitat. Kurta (2005) noted that impacts on reproductive success are a likely consequence of the loss of traditional roost sites. He suggested that reduced reproductive success may be related to stress, poor microclimate in new roosts, a reduced ability to thermoregulate through clustering, or reduced ability to communicate and thus locate quality foraging areas. He further suggested that the magnitude of these impacts would vary greatly depending on the scale of roost loss (i.e., how many roosts are lost and how much alternative habitat is left for the bats in the immediate vicinity of the traditional roost sites). Recovery from the stress of hibernation and migration may be slower as a result of the added energy demands of searching for new roosting/foraging habitat especially in an already fragmented landscape where forested habitat is limited. Pregnant females displaced from preferred roosting/foraging areas will have to expend additional energy to search for alternative habitat; which would likely result in reduced reproductive success for some females. Females that do give birth may have pups with lower birth weights given the increased energy demands associated with longer flights, or their pups may experience delayed development. These longer flights would also be experienced by pups once they become volant which could affect the survival of these pups as they enter hibernation with potentially reduced fat reserves. Overall, the effect of the loss of roosting/foraging habitat on individual bats from the maternity colonies may range from no effect to death of juveniles. The effect on the colonies could then be reduced reproduction for that year.

Literature Cited

Amelon, S., and D. Burhans. 2006. Conservation assessment: *Myotis septentrionalis* (northern long-eared bat) in the eastern United States. Pages 69-82 *in* Thompson, F. R., III, editor. Conservation assessments for five forest bat species in the eastern United States. U.S. Department of Agriculture, Forest Service, North Central Research Station, General Technical Report NC-260. St. Paul, Minnesota. 82pp.

Barbour, R.W., and W.H. Davis. 1969. Bats of America. The University of Kentucky Press, Lexington, Kentucky. 311pp.

Brack Jr., V. and J. O. Whitaker Jr. 2001. Foods of the northern myotis, *Myotis septentrionalis*, from Missouri and Indiana, with notes on foraging. Acta Chiropterologica 3:203–210.

Caceres, M.C. and M.J. Pybus. 1997. Status of the northern long-eared bat (*Myotis septentrionalis*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 3, Edmonton, AB, 19pp.

Caceres, M.C. and R.M.R. Barclay. 2000. Myotis Septentrionalis. Mammalian Species 634:1-4.

Callahan, E. V., R. D. Drobney, and R. L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (Myotis sodalis) in Missouri. Journal of Mammalogy 78:818–825.

Griffin, D.R. 1940. Notes on the life-histories of New England cave bats. Journal of Mammology 21:181-187.

Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Scientific Publications No. 12. Reading Public Museum and Art Gallery, Reading, PA.

Henshaw, R.E. 1965. Physiology of hibernation and acclimatization in two species of bats (Myotis lucifugus and Myotis sodalis). Ph.D. Dissertation. University of Iowa, Iowa City, IA. 143 pp.

Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, Myotis sodalis. Florida Scientist 41:65-76.

Kurta, A. 2005. Roosting ecology and behavior of Indiana bats (myotis sodalis) in summer. Pp. 29-42 *in* K.C. Vories and A. Harrington (eds.), Proceedings of the Indiana bat and coal mining: a technical interactive forum. Office of Surface Mining, U.S. Department of the Interior, Alton, IL. Available at http://www.mcrcc.osmre.gov/pdf/forums/bat%20Indiana/TOC.pdf.

Kurta, A., S.W. Murray and D.H. Miller. 2002. Roost selection and movements across the summer landscape. Pp. 118-129 *in* Kurta, A. and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Department of Conservation, Terrestrial Series 8:1-52.

Myers, R.F. 1964. Ecology of three species of myotine bats in the Ozark Plateau. Ph.D. Dissertation. University of Missouri, Columbia, MO. 210 pp.

Patriquin, K.J. and R.M. Barclay. 2003. Foraging by bats in cleared, thinned and unharvested boreal forest. Journal of Applied Ecology, 40:646-657.

Tuttle, M. D., and J. Kennedy. 2002. Thermal requirements during hibernation. Pages 68-78 *In* Kurta, A., and J. Kennedy, editors. The Indiana bat: biology and management of an endangered s pecies. Bat Conservation International, Austin, TX.

van Zyll de Jong, C. G. 1985. Handbook of Canadian mammals. National Museums of Canada, Ottawa, Canada. pp. 116-120.

Whitaker, J.O., Jr., and L.J., Rissler. 1992. Seasonal activity of bats at Copperhead Cave. Proceedings of the Indiana Academy of Science 101:127-135.

Yates, M.D., and R.M. Muzika. 2006. Effect of forest structure and fragmentation on site occupancy of bat species in Missouri Ozark Forests. The Journal of Wildlife Management, 70(5):1238-1248.

APPENDIX B.
Recommendations for Avoidance and Minimization Measures

All projects must include seasonal clearing

- Avoid impacts to potential roost trees (e.g., avoid cutting these trees).
- Avoid impacts to documented foraging areas or areas which are likely to support foraging.
- To minimize impacts on foraging and roosting Indiana bats/NLEB, avoid or minimize impacts on forests, woodlands, and forested fence rows. Configure projects to avoid and/or minimize impacts on suitable summer and swarming habitat, particularly in and around wetlands and riparian areas.
- Minimize the right-of-way (ROW) by narrowing or rerouting the ROW around high quality Indiana bat summer habitat.
- Retain at least a 50-foot forested buffer (but preferably a 100-150 foot buffer) on each side of streams and around wetlands.
- Co-locate project features (*e.g.*, roads and utility lines) and cluster project features (*e.g.*, houses) to reduce forest clearing.
- Phase tree clearing over multiple years, if applicable to the project. Indicate the rate at which forest will be cleared, as well as the total duration of this effect (e.g., 5 acres/year for 10 years).
- Reforest temporarily cleared areas with tree species preferred by Indiana bats/NLEB, in accordance with Appendix C. Ensure soils are segregated during earth disturbance activities and ensure soils are not compacted, to allow for successful tree establishment.
- Restore or enhance degraded riparian areas or wetlands by planting native trees and shrubs.
- Avoid use of invasive, exotic plant species when re-foresting and when stabilizing soils.
- Develop and implement stringent erosion and sedimentation controls to protect water quality and the Indiana bat/NLEB prey base in streams and wetlands.
- Develop and implement a pollution prevention plan with strong erosion and sedimentation best management practices to ensure hazardous materials and storm runoff do not contaminate soils, wetlands, or waterways.
- Set aside protected suitable habitat within or adjacent to the project area to ensure that undisturbed bat habitat will remain on the landscape.

Recommendations for Conservation Measures When Impacts are Unavoidable

- Girdling trees on a 1:1 ratio for each potential roost tree that is lost during project development
- Erecting bat boxes, artificial bark, or other artificial roosting structures and monitoring these structures, or combination of structures, for a minimum of two years. The Service highly recommends that project proponents use artificial roosting structures on a 1:1 ratio to replace each potential primary roost tree that is lost during project development.
- Preserve suitable Indiana bat/NLEB habitat off-site permanently.
- Create watering areas for bats such as wetlands or ponds.

APPENDIX C.
Preferred Tree Species

Planting plans should include at least six of the tree species listed below, one of which should be shagbark hickory. To promote diversity, do not include more than 15 percent of any one tree species in planting plans.

Acer rubrum	red maple
Acer saccharum	sugar maple
Carya cordiformis	bitternut hickory
Carya glabra	pignut hickory
Carya laciniosa	shellbark hickory
Carya ovata	shagbark hickory
Carya tomentosa	mockernut hickory
Fraxinus americana	white ash
Fraxinus nigra	black ash
Fraxinus pennsylvanica	green ash
Platanus occidentalis	sycamore
Populus deltoides	eastern cottonwood
Quercus alba	white oak
Quercus coccinea	scarlet oak
Quercus prinus	chestnut oak
Quercus rubra	northern red oak
Quercus velutina	black oak
Robinia pseudoacacia	black locust
Sassafras albidum	sassafras
Ulmus americana	American elm
Ulmus rubra	slippery elm

APPENDIX D.

Potential Roost Tree Information Sheet

Please provide tabular information as shown below along with photos of each tree and a map that shows the location of each tree along the project limits-of-disturbance.

Tree ID#	**Species**	**DBH** (inches)	**Live/Dead**	**Coordinates**	**Avoid/Unavoid**

Potential Roost Tree Information Sheet

Please provide tabular information as shown below along with photos of each tree and a map that shows the location of each tree along the project limits-of-disturbance.

Tree ID#	**Species**	**DBH** (inches)	**Live/Dead**	**Coordinates**	**Avoid/Unavoid**

APPENDIX E.

In the table below list <u>all</u> projects[‡] performed by the project proponent[§] that have occurred within the 2-mile buffer in the past five years.

Project Title	Type of Project	Year of Concurrence	Year of Project Completed / to be Completed	GPS Coordinates	Tentative Amount of Tree Clearing

[‡] Such as well pads and associated features (access roads, staging areas, tank pads, etc.), pipelines and their associated features (roads, staging areas, etc.), compressor stations, processing facilities, etc. *and* including projects submitted for the project proponent by other consultants.

[§] Whereby project proponent refers to the current company, its subsidiaries, and any other names the company may have previously been known as.

In the table below list <u>all</u> projects[**] performed by the project proponent[††] that have occurred within the 2-mile buffer in the past five years.

Project Title	Type of Project	Year of Concurrence	Year of Project Completed / to be Completed	GPS Coordinates	Tentative Amount of Tree Clearing

[**] Such as well pads and associated features (access roads, staging areas, tank pads, etc.), pipelines and their associated features (roads, staging areas, etc.), compressor stations, processing facilities, etc. *and* including projects submitted for the project proponent by other consultants.

[††] Whereby project proponent refers to the current company, its subsidiaries, and any other names the company may have previously been known as.

APPENDIX F.
Useful Terminiology

- "Known habitat" refers to suitable summer or winter habitat located within 10 miles of a documented priority 1 or 2 hibernacula, within 5 miles of a documented maternity capture record or documented priority 3 or 4 hibernacula, or within 2.5 miles of a documented maternity roost tree.

- "Maternity habitat" refers to suitable summer habitat used by juveniles and reproductive (pregnant, lactating, or post-lactating) females.

- "Non-maternity habitat" refers to suitable summer habitat used by non-reproductive females and/or males.

- "Occupied" refers to suitable habitat that is expected or assumed to be in use by Indiana bats or NLEB at the time of impact.

- "Potential habitat" occurs statewide where suitable roosting, foraging and travel habitat for the Indiana bat and NLEB exists. Known habitat also includes potential habitat for those currently undocumented uses.

- "Suitable habitat" refers to summer and/or winter habitat that is appropriate for use by Indiana bats/NLEB.

    - Suitable winter habitat for Indiana bats (hibernacula) is restricted to underground caves and cave-like structures (e.g., abandoned mines, railroad tunnels). These hibernacula typically have a wide range of vertical structures; cool, stable temperatures, preferably between 4°C and 8°C; and humidity levels above 74% but below saturation.
    - Suitable winter habitat for the NLEB is also restricted to underground caves and cave-like structures (e.g., abandoned mines, railroad tunnels). Hibernacula for NLEB typically have significant cracks and crevices for roosting; relatively constant, cool temperatures (0-9 degrees Celsius) and have high humidity and minimal air currents.
    - Suitable summer habitat consists of the variety of forested/wooded habitats where they roost, forage and travel. This includes forested blocks as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Isolated trees are considered suitable habitat when they exhibit the characteristics of a suitable roost tree.

- "Suitable primary maternity roost tree or central-node" Refers to a dead or partially dead tree that is at least 9 inches DBH and has cracks, crevices, and/or loose or exfoliating bark. Trees in excess of 16 inches DBH are considered optimal for maternity colony roosts, but trees in excess of 9 inches DBH appear to provide suitable maternity roosting habitat. Primary roosts/central-nodes are often found near clearings or edges of woodlands where they receive greater solar radiation, a factor that may be important for reproductive females and their young[7]. Primary roosts/central-nodes occur in open forest, along the edge of a woodlot, in gaps within a forest, in a copse of dead trees, as part of a wooded fenceline, in grazed woodlands, or in pastures with scattered trees[8].

- "Suitable roost tree" refers to a tree (live or dead) with a DBH of 3 inches or greater that exhibits any of the following characteristics: exfoliating bark, crevices, or cracks. Indiana bats/NLEB typically roost under exfoliating bark, and in cavities of dead, dying, and live trees, and in snags (i.e., dead trees or dead portions of live trees).

- "Unoccupied" refers to suitable habitat not expected to be in use by Indiana bats/NLEB at the time of impact.

[7] Vonhof, M.J. and R.M.R. Barclay. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. *Canadian Journal of Zoology*. 74:1797-1805.
[8] Gardner J.E., J.D. Garner, and J.E. Hofmann. 1991. Summer roost selection and roosting behavior of *Myotis soldais* (Indiana bat) in Illinois. Unpublished report. Illinois Natural History Survey. Champaign. 56p.